WHAT IS CLAIMED IS:

1. An evaporated fuel processing apparatus for an internal combustion engine, comprising:

a canister that adsorbs a fuel vapor generated within a fuel tank;

a gas flow detecting mechanism that detects a flow of gas at least at a predetermined flow rate between the fuel tank and the canister, the predetermined flow rate being higher than a flow rate of gas normally flowing between the fuel tank and the canister which are communicated with each other;

a canister temperature detector that detects a temperature of the canister; and

a controller that:

detects one of an upper peak value and a lower peak value of the temperature of the canister caused in a continual state of the flow of gas at least at the predetermined flow rate detected by the gas flow detecting mechanism; and

estimates a fuel adsorbing state within the canister on the basis of the canister temperature obtained subsequent to a detection of the one of the upper peak value and the lower peak value.

2. The evaporated fuel processing apparatus according to claim 1, wherein:

the canister includes a purge port communicated with an intake passage of the internal combustion engine; and

the canister temperature detector comprises a canister temperature sensor disposed around the purge port such that a temperature within the canister is detected.

3. The evaporated fuel processing apparatus according to claim 2, wherein the controller obtains:

a fuel vapor concentration of the gas flowing between the fuel tank and the canister in the continual state of the flow of gas at least at the predetermined flow rate; and

a flow rate of the gas flowing between the fuel tank and the canister in the continual state of the flow of gas at least at the predetermined flow rate;

and

the controller further estimates the fuel adsorbing state on the basis of the canister temperature obtained subsequent to the detection of the one of the upper peak value and the lower peak value, the fuel vapor concentration, and the flow rate of the gas.

4. The evaporated fuel processing apparatus according to claim 3, wherein the controller:

contains a map that stores the fuel adsorbing state within the canister defined by the canister temperature, the fuel vapor concentration, and the flow rate of the gas; and

refers to the map so as to determine the fuel adsorbing state in accordance with the canister temperature obtained subsequent to the detection of the one of the upper peak value and the lower peak value, the fuel vapor concentration, and the flow rate of the gas.

5. The evaporated fuel processing apparatus according to claim 4, wherein the gas flow detecting mechanism detects a flow of gas containing fuel vapor at least at the predetermined flow rate from the fuel tank to the canister upon a fuel supply.

6. The evaporated fuel processing apparatus according to claim 5, further comprising a tank vapor temperature detector that detects a vapor temperature within the fuel tank, wherein the controller obtains a saturated vapor pressure of a fuel vapor within the fuel tank on the basis of the tank vapor temperature, and further obtains a concentration of the fuel vapor on the basis of a ratio of the saturated vapor pressure to an atmospheric pressure.

7. The evaporated fuel processing apparatus according to claim 6, further comprising a space capacity detector that detects a space capacity of the fuel tank, wherein the controller obtains a flow rate of the gas on the basis of a change in the space capacity as an elapse of time.

8. The evaporated fuel processing apparatus according to claim 4, further comprising an in-tank control valve that controls communication between the fuel tank and the canister, and a differential pressure detector that detects a differential pressure generated between a side of the fuel tank and a side of the canister with respect to the in-tank control valve in a closed state, wherein the controller serves to open the in-tank control valve when the detected differential pressure is at least a

predetermined valve opening pressure such that the gas flows at least at the predetermined flow rate between the fuel tank and the canister.

9. The evaporated fuel processing apparatus according to claim 8, further comprising a tank vapor temperature detector that detects a vapor temperature within the fuel tank, wherein the controller obtains:

a saturated vapor pressure of a fuel vapor within the fuel tank on the basis of the tank vapor temperature;

an inner pressure of the fuel tank; and

a first fuel vapor concentration on the basis of a ratio of the saturated vapor pressure to the inner pressure of the fuel tank when the gas flows at least at the predetermined flow rate from the fuel tank to the canister.

10. The evaporated fuel processing apparatus according to claim 9, wherein the controller obtains:

a saturated vapor pressure of the fuel vapor within the canister on the basis of the canister temperature; and

a second fuel vapor concentration on the basis of a ratio of the saturated vapor pressure to an atmospheric pressure when the gas flows at least at the predetermined flow rate from the canister to the fuel tank.

11. The evaporated fuel processing apparatus according to claim 10, wherein the controller obtains:

the inner pressure of the fuel tank; and

a first flow rate of the gas that flows at least at the predetermined flow rate from the fuel tank to the canister using a formula:

Formula:

$$m = Cd\frac{Pin}{\sqrt{RTin}}Aval\left(\frac{Pout}{Pin}\right)^{\frac{1}{r}}\sqrt{\frac{2r}{r-1}\left\{1-\left(\frac{Pout}{Pin}\right)^{\frac{r-1}{r}}\right\}}$$

where Pout as a pressure at an outflow side represents the inner pressure of the fuel tank, Tin as a temperature at an inflow side represents the canister temperature, Pin as a pressure at the inflow side represents the atmospheric pressure, Cd represents a flow rate coefficient indicating compressibility, r represents a ratio of the specific heat, R represents a gas constant, and Aval represents an opening area of the in-tank control valve.

12. The evaporated fuel processing apparatus according to claim 11,

wherein the controller obtains:

the tank vapor temperature within the fuel tank;

the inner pressure of the fuel tank; and

a second flow rate of the gas that flows at least at the predetermined flow rate from the canister to the fuel tank using a formula:

Formula:

$$m = Cd\frac{Pin}{\sqrt{RTin}}Aval\left(\frac{Pout}{Pin}\right)^{\frac{1}{r}}\sqrt{\frac{2r}{r-1}\left\{1-\left(\frac{Pout}{Pin}\right)^{\frac{r-1}{r}}\right\}}$$

where Pout as the pressure at the outflow side represents the atmospheric pressure, the Tin as the temperature at the inflow side represents the tank vapor temperature within the fuel tank, the Pin as the pressure at the inflow side represents the inner pressure of the fuel tank, Cd represents the flow rate coefficient indicating compressibility, r represents the ratio of the specific heat, R represents the gas constant, and Aval represents the opening area of the in-tank control valve.

13. The evaporated fuel processing apparatus according to claim 12, wherein the controller comprises an in-tank pressure sensor for detecting the inner pressure of the fuel tank.

14. The evaporated fuel processing apparatus according to claim 13, further comprising a space capacity detector that detects a space capacity of the fuel tank, wherein the controller:

obtains the saturated vapor pressure of the fuel vapor within the fuel tank on the basis of the tank vapor temperature;

serves to block the fuel tank by closing the in-tank pressure control valve after the inner pressure of the fuel tank becomes the atmospheric pressure; and

obtains a total number of moles of the gas within the fuel tank on the basis of the space capacity, the vapor temperature, and the atmospheric pressure obtained when the fuel tank is blocked; a number of moles of air within the fuel tank on the basis of a ratio of the saturated vapor pressure to the atmospheric pressure and the total number of moles; a partial pressure of air within the fuel tank on the basis of the number of moles of air, the space capacity, and the vapor temperature obtained when a block state of the fuel tank is held; and an inner pressure of the fuel tank by adding the saturated vapor pressure to the partial pressure of air.

15. An evaporated fuel processing method for an internal combustion engine including a canister for adsorbing a fuel vapor generated within a fuel tank, the

evaporated fuel processing method comprising:

detecting a flow of gas at least at a predetermined flow rate between the fuel tank and the canister, the predetermined flow rate being higher than a flow rate of gas normally flowing between the fuel tank and the canister which are communicated with each other;

detecting a temperature of the canister;

detecting one of an upper peak value and a lower peak value of the temperature of the canister caused in a continual a state of the flow of gas at least at the predetermined flow rate detected by the gas flow detecting mechanism; and

estimating a fuel adsorbing state within the canister on the basis of the canister temperature obtained subsequent to a detection of the one of the upper peak value and the lower peak value.

16. The evaporated fuel processing method according to claim 15, wherein:

a fuel vapor concentration of the gas flowing between the fuel tank and the canister is obtained in the continual state of the flow of gas at least at the predetermined flow rate;

a flow rate of the gas flowing between the fuel tank and the canister is obtained in the continual state of the flow of gas at least at the predetermined flow rate; and

the fuel adsorbing state is estimated on the basis of the canister temperature obtained subsequent to the detection of the one of the upper peak value and the lower peak value, the fuel vapor concentration, and the flow rate of the gas.

17. The evaporated fuel processing method according to claim 16, wherein a map that stores the fuel adsorbing state within the canister defined by the canister temperature, the fuel vapor concentration, and the flow rate of the gas is referred to determine the fuel adsorbing state in accordance with the canister temperature obtained subsequent to the detection of the one of the upper peak value and the lower peak value, the fuel vapor concentration, and the flow rate of the gas.

18. The evaporated fuel processing method according to claim 17, wherein a flow of gas containing fuel vapor at least at the predetermined flow rate from the fuel tank to the canister upon a fuel supply is detected.

19. The evaporated fuel processing method according to claim 18, wherein

a vapor temperature within the fuel tank is detected, and a saturated vapor pressure of a fuel vapor within the fuel tank is obtained on the basis of the vapor temperature, and a concentration of the fuel vapor is further obtained on the basis of a ratio of the saturated vapor pressure to an atmospheric pressure.

20. The evaporated fuel processing method according to claim 19, wherein a space capacity of the fuel tank is detected, and a flow rate of the gas is obtained on the basis of a change in the space capacity as an elapse of time.

21. The evaporated fuel processing method according to claim 17, wherein communication between the fuel tank and the canister is controlled, a differential pressure generated between a side of the fuel tank and a side of the canister with respect to the in-tank control valve in a closed state is detected, and the in-tank control valve is opened when the detected differential pressure is at least a predetermined valve opening pressure such that the gas flows at least at the predetermined flow rate between the fuel tank and the canister.

22. The evaporated fuel processing method according to claim 21, wherein:

a vapor temperature within the fuel tank is detected;

a saturated vapor pressure of a fuel vapor within the fuel tank is obtained on the basis of the tank vapor temperature;

an inner pressure of the fuel tank is obtained; and

a first fuel vapor concentration is obtained on the basis of a ratio of the saturated vapor pressure to the inner pressure of the fuel tank when the gas flows at least at the predetermined flow rate from the fuel tank to the canister.

23. The evaporated fuel processing method according to claim 22, wherein:

a saturated vapor pressure of the fuel vapor within the canister is obtained on the basis of the canister temperature; and

a second fuel vapor concentration is obtained on the basis of a ratio of the saturated vapor pressure to an atmospheric pressure when the gas flows at least at the predetermined flow rate from the canister to the fuel tank.

24. The evaporated fuel processing method according to claim 23, wherein:

the inner pressure of the fuel tank is obtained; and

a first flow rate of the gas that flows at least at the predetermined flow

rate from the fuel tank to the canister is obtained using a formula:

Formula:

$$m = Cd\frac{Pin}{\sqrt{RTin}}Aval\left(\frac{Pout}{Pin}\right)^{\frac{1}{r}}\sqrt{\frac{2r}{r-1}\left\{1-\left(\frac{Pout}{Pin}\right)^{\frac{r-1}{r}}\right\}}$$

where Pout as a pressure at an outflow side represents the inner pressure of the fuel tank, Tin as a temperature at an inflow side represents the canister temperature, Pin as a pressure at the inflow side represents the atmospheric pressure, Cd represents a flow rate coefficient indicating compressibility, r represents a ratio of the specific heat, R represents a gas constant, and Aval represents an opening area of the in-tank control valve.

25. The evaporated fuel processing method according to claim 24, wherein:

the tank vapor temperature within the fuel tank, the inner pressure of the fuel tank; and

a second flow rate of the gas that flows at least at the predetermined flow rate from the canister to the fuel tank is obtained using a formula:

Formula:

$$m = Cd\frac{Pin}{\sqrt{RTin}}Aval\left(\frac{Pout}{Pin}\right)^{\frac{1}{r}}\sqrt{\frac{2r}{r-1}\left\{1-\left(\frac{Pout}{Pin}\right)^{\frac{r-1}{r}}\right\}}$$

where Pout as the pressure at the outflow side represents the atmospheric pressure, the Tin as the temperature at the inflow side represents the tank vapor temperature within the fuel tank, the Pin as the pressure at the inflow side represents the inner pressure of the fuel tank, Cd represents the flow rate coefficient indicating compressibility, r represents the ratio of the specific heat, R represents the gas constant, and Aval represents the opening area of the in-tank control valve.

26. The evaporated fuel processing method according to claim 25, wherein:

a space capacity of the fuel tank is detected; the saturated vapor pressure of the fuel vapor within the fuel tank is obtained on the basis of the tank vapor temperature;

the fuel tank is blocked by closing the in-tank pressure control valve after the inner pressure of the fuel tank becomes the atmospheric pressure;

a total number of moles of the gas within the fuel tank is obtained on

the basis of the space capacity, the vapor temperature, and the atmospheric pressure obtained when the fuel tank is blocked;

a number of moles of air within the fuel tank is obtained on the basis of a ratio of the saturated vapor pressure to the atmospheric pressure and the total number of moles;

a partial pressure of air within the fuel tank is obtained on the basis of the number of moles of air, the space capacity, and the vapor temperature obtained when a block state of the fuel tank is held; and

an inner pressure of the fuel tank is obtained by adding the saturated vapor pressure to the partial pressure of air.